

PATENT SPECIFICATION

793,452

Inventor :—DAVID HERBERT YOUNG.



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International Classification :—A62b. F06k.

COMPLETE SPECIFICATION.

Improvements in Breathing Apparatus for Use in Aircraft.

We, THE WALTER KIDDE COMPANY LIMITED, a British Company, of Belvue Road, Northolt, Greenford, Middlesex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

The present invention relates to oxygen breathing apparatus for use in aircraft and in particular it relates to a multiple outlet, "demand" type system, which is designed to supply oxygen at substantially constant pressure to the user.

It is an object of the present invention to provide a system in which several outlets are fed from one main regulator, as is required for use in multi-seat aircraft.

The regulator of an aircraft breathing system contains a barometric element which is adapted to increase or decrease the pressure on the outlet side of the regulator in response to the surrounding atmospheric pressure so as to adjust the operation of the system relative to the surrounding atmosphere.

The main problem arising in using a single barometrically-compensated regulator for a multi-outlet system is that if the outlet pressure from the regulator is at the low pressure required for the mask supply, then very large pipes would be required for the leads from the regulator to the masks.

According to the present invention a multiple-outlet breathing apparatus for use in aircraft comprises a master regulator, having an inlet connected to a high-pressure oxygen supply and an outlet connected to a multiple-outlet-distribution manifold, said master regulator being adapted to supply oxygen to the distribution manifold at a variable intermediate pressure of the order of 100 p.s.i., said distribution manifold having

multiple outlets and individual breathing units adapted to be connected to said outlets, each of said breathing units comprising a face mask and a slave regulator in the form of a reducing valve adapted to reduce the intermediate oxygen pressure to a pressure required for breathing by the wearer of the mask, the apparatus being arranged so that the outlet pressure of the slave regulators at the face masks can be controlled by change of the master regulator outlet pressure.

The supply of oxygen to the manifold at a relatively high intermediate pressure permits the manifold itself to be of relatively small diameter and, more important, permits the flexible pipes leading from the manifold to the slave regulator and the mask of the individual breathing units also to be of relatively small size. The actual intermediate pressure employed in the manifold may be varied through wide limits, it being really essential only that the pressure in the manifold should be compensated for altitude and such that it provides adequate oxygen flow through relatively small diameter flexible hoses, whilst being at a pressure sufficiently low as to avoid damage to the flexible hoses connecting the manifold to the mask.

Oxygen breathing installation for use in aircraft are hereinafter described with reference to Figures 1 and 2 of the drawings filed with the Provisional Specification and with reference to the accompanying drawings, wherein :—

Figure 3 is a diagram of one form of system.

Figure 4 is a diagram of a modified form of system.

Figure 5 is a section of a barometrically controlled release valve for use in the system of Figure 4.

Figure 6 is a section of a barometrically-controlled regulating valve.

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It is an object of the present invention to provide a system in which several outlets are fed from one main regulator, as is required for use in multi-seat aircraft.

The regulator of an aircraft breathing system contains a barometric element which is adapted to increase or decrease the pressure on the outlet side of the regulator in response to the surrounding atmospheric pressure so as to adjust the operation of the system relative to the surrounding atmosphere.

The main problem arising in using a single barometrically-compensated regulator for a multi-outlet system is that if the outlet pressure from the regulator is at the low pressure required for the mask supply, then very large pipes would be required for the leads from the regulator to the masks.

According to the present invention a multiple-outlet breathing apparatus for use in aircraft comprises a master regulator, having an inlet connected to a high-pressure oxygen supply and an outlet connected to a multiple-outlet-distribution manifold, said master regulator being adapted to supply oxygen to the distribution manifold at a variable intermediate pressure of the order of 100 p.s.i., said distribution manifold having

multiple outlets and individual breathing units adapted to be connected to said outlets, each of said breathing units comprising a face mask and a slave regulator in the form of a reducing valve adapted to reduce the intermediate oxygen pressure to a pressure required for breathing by the wearer of the mask, the apparatus being arranged so that the outlet pressure of the slave regulators at the face masks can be controlled by change of the master regulator outlet pressure.

The supply of oxygen to the manifold at a relatively high intermediate pressure permits the manifold itself to be of relatively small diameter and, more important, permits the flexible pipes leading from the manifold to the slave regulator and the mask of the individual breathing units also to be of relatively small size. The actual intermediate pressure employed in the manifold may be varied through wide limits, it being really essential only that the pressure in the manifold should be compensated for altitude and such that it provides adequate oxygen flow through relatively small diameter flexible hoses, whilst being at a pressure sufficiently low as to avoid damage to the flexible hoses connecting the manifold to the mask.

Oxygen breathing installation for use in aircraft are hereinafter described with reference to Figures 1 and 2 of the drawings filed with the Provisional Specification and with reference to the accompanying drawings, wherein :—

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Figure 4 is a diagram of a modified form of system.

Figure 5 is a section of a barometrically controlled release valve for use in the system of Figure 4.

Figure 6 is a section of a barometrically-controlled regulating valve.

[Price

Figure 7 is a section of a modified construction of mask valve.

One oxygen breathing installation made in accordance with the present invention is shown in Figure 3 and comprises a main oxygen supply, comprising oxygen cylinders 31 adapted to supply oxygen at a pressure of, for example, 500—3000 p.s.i. or alternatively liquid oxygen evaporating equipment 32 adapted to supply oxygen at a lower pressure. Oxygen is led from the main supply to a master regulator 33 which is barometrically compensated and of known construction and adapted to supply oxygen at a pressure of 60—120 p.s.i. to a manifold 34 connected to the outlet of the master regulator 33. The manifold 34 may be constructed of a relatively slender rigid metal tube, provided with a plurality of outlets 35, which are self-sealing and are adapted to receive an end connector member of a flexible hose 36, supplying a slave regulator 37 and a mask 38.

The pressure in the hose 36 will be the same substantially, as the manifold pressure and the outlet pressure of the slave regulator 37 has to be controlled between $-2''$ and $+20''$ water gauge, relative to the surrounding atmosphere to ensure that the mask pressure is physiologically correct.

The regulator system thus consists of the master regulator 33 which controls the manifold pressure to 60—120 p.s.i. according to the altitude of the aircraft, whilst the slave regulators 37 reduce the manifold pressure to the correct mask pressure for the altitude.

The slave regulator valve 37 must be both compact and light for use in the present apparatus. One convenient form of slave regulator valve is a simple form of reducing valve which responds to inlet pressure in such a way that the pressure delivered to the mask increases as the pressure in the distribution manifold falls, so that with this type of slave regulator, the barometric element of the master regulator 33 is set to reduce the manifold pressure with increase of altitude.

The reducing valve itself is shown in Figure 1 and consists of a valve member 1 attached to a diaphragm 2 mounted in the wall of the valve on the low-pressure side of the valve. The diaphragm 2 is backed by a spring 3 held in a vented casing 4 on the outside of the valve, so that the spring 3 balances the thrust resulting from the pressure difference across the diaphragm 2. The valve member 1 is provided with a spindle 5 and a conical head 5A. The conical head 5A is located in the high-pressure inlet side of the valve and the spindle 5 is supported in a guide 6 and connected to the diaphragm 2. Increase in oxygen pressure in the inlet passage 7 of the valve forces the valve head 5A towards the shoulder 8 and this reduces the effective thrust of the spring 3. By correctly pro-

portioning the parts of the valve, it can be arranged so that the pressure in the outlet 9 decreases as the pressure in the inlet 7 increases.

A modified construction of slave regulator is shown in section in Fig. 2. This valve has been devised in order to give increased oxygen economy and is constructed so as to give increased mask pressure with increased inlet pressure. In consequence, the master regulator 33 is arranged to give increase of manifold pressure with increase of altitude.

The modified regulator comprises a body 11, having inlet and outlet passages 12 and 14. A valve member 15 is secured to a diaphragm 16, backed by a spring 17 held in a case 18. As before the valve member is provided with a spindle 19 and a conical head 20. In this case, although increased pressure in the inlet passage 12 causes the valve member to move towards its seating member 21, the seating member 21 in this instance is itself movable and is supported on a diaphragm in the form of a resilient bellows member 22, which moves further on increase of pressure in the inlet passage, with the result that the effective aperture between the valve head 20 and the seating member 21 increases and in consequence the pressure in the passage 14 increases.

A further feature of this valve is that the body 11 of the valve is provided with a venturi 24 and is provided with air inlet ports 25, so that as oxygen issues from the seating member 21 into the venturi 24, it induces air through the ports 25 into the inlet passage 14, thus leading to a considerable economy in stored oxygen. As the bellows 22 expand, the tapered outer surface of the member 21 reduces the size of the effective aperture through which air can enter, eventually completely sealing it off, so that the slave regulator also automatically controls the composition of the breathing mixture delivered to the mask.

The venturi 24 and ports 25 can however be omitted without affecting the general principle of operation of the slave regulator.

Emergency and test pressures at the mask can be obtained with both the above forms of slave regulator by increasing the pressure of the slave regulator spring by means of a cam or push button, so as to increase the opening of the regulating valve.

Failure to operate will be due to lack of pressure in the distribution manifold and a simple pressure gauge on the master regulator should give sufficient warning of faulty operation. Any failure in the slave regulator can be overcome by manual pressure on its control spring as described above. Alternatively, a manual by-pass valve can be fitted, which would make the system equivalent to a conventional controlled flow type of apparatus.

The use of this system in civil aircraft has a number of advantages :—

1. The number of complex regulators can be greatly reduced.
- 5 2. The system will give complete safety up to the limit of pressure breathing conditions.
3. The master regulator incorporates a barometric control and can be arranged to operate automatically should the

10 cabin pressure fall below that corresponding to an altitude of say 10,000 ft. A modified breathing system is shown in Figure 4 designed for automatic operation

15 when the cabin pressure falls below a predetermined minimum value. The supply of oxygen from cylinders 31 is controlled by a release valve 40, which is adapted to open automatically at a predetermined barometric pressure, but is also provided with an over-

20 riding manual control to enable it to be opened in emergency. The pressure of the oxygen passing through the valve 40 is then reduced by a master regulator 33, which is

25 shown as a manually controlled reducing valve of known construction. The pressure in the manifold 34 is then manually controlled in accordance with aircraft altitude, the manifold pressure being indicated by a gauge

30 41. The manually controlled master regulator 33 may be replaced by a barometrically-controlled regulating valve such as that shown in Figure 6.

35 Figure 5 shows one construction of the release valve 40 placed between the high pressure oxygen supply and master regulator. In some instances this mechanism can be incorporated in the master regulator itself in one assembly.

40 The barometrical release valve 40 comprises a body 42 having a housing 43 in which is positioned a sealed bellows 44 having a push-rod 45 which can be pre-set by means of an adjusting-screw 46 to engage a trip lever 47

45 at a predetermined atmospheric pressure. The trip lever 47 is pivoted to the body 42 and when depressed, it releases a valve release lever 48, which acts as a stop for a main spring 49. The valve member 50,

50 normally held against its seat by a spring 51, is unseated by the pressure of the spring 49, when the lever 48 is released, to permit gas to pass to the master regulator. A manual control screw 52 is arranged in such a way that

55 the valve 50 can be unseated independently of the barometric release mechanism. The screw 54 is included for raising the lever member 48 for resetting the trip mechanism after operation.

60 Figure 6 shows a barometrically controlled valve for use as a master regulator. This valve comprises a conventional reducing valve mechanism in which the position of the valve member 61 is primarily controlled by

65 the effect of the outlet pressure on a dia-

phragm 62, to which the valve member 61 is secured. In this valve a sealed bellows 63 is incorporated. The bellows 63 is exposed to atmosphere and carries a thrust member 64 which can bear down on the diaphragm 62 and

70 augment the loading of the normal control spring 65 when the ambient atmospheric pressure drops. This form of regulator will increase the pressure in the distribution manifold 34 as the aircraft altitude increases

75 and atmospheric pressure decreases and would be used with the slave regulators shown in Figure 2 or Figure 7. If used with a regulator of the type shown in Figure 1 the bellows 63 would be arranged to reduce the

80 loading of the control spring 65 as the aircraft flies higher, by means of a system of levers or the like.

The slave regulator shown in Figure 7 is an alternative to that shown in Figure 2 and does not include means for automatically

85 diluting the oxygen supplied to the mask with air.

In the construction shown in Figure 7, the control valve member 71 is held shut by means of the control spring 72, but as the pressure in the inlet manifold 73 increases, the force on the small diaphragm 74, which supports one end of the valve member 71,

90 acts against the pressure of the spring 72. The proportions of the valve can be so arranged that at a pressure of say 60 p.s.i. in the inlet manifold 73 a suction pressure in the order of 2" water gauge acting on the main

95 diaphragm 75 is required to unseat the valve member 71. If the input pressure is raised to say 120 lbs. p.s.i. on increase of aircraft altitude the force of the small diaphragm 74 will then overcome the pressure of the control spring 72 so that the slave regulator will

100 deliver oxygen at a positive pressure of up to, say 20" water gauge at the mask, thus giving the increase in mask pressure required to compensate for decrease in the ambient atmospheric pressure.

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An oxygen set suitable for baling out of an aircraft can be formed by connecting the slave regulator to a small storage cylinder fitted with a reducing valve, which performs for the bale-out set the same function as the

115 master regulator does for the main system. The reducing valve on the bale-out cylinder may be pre-set to give a constant pressure in the lead to the slave regulator or, in more advanced constructions, a barometrically-

120 compensated reducing valve could be employed with the bale-out cylinder.

What we claim is :—

1. A multiple outlet breathing apparatus for use in aircraft comprising a master regu-

125 lator, having an inlet connected to a high-pressure oxygen supply and an outlet connected to a multiple outlet distribution manifold, said master regulator being adapted to

supply oxygen to the distribution manifold at a variable intermediate pressure of the order of 100 p.s.i., said distribution manifold having multiple outlets and individual breathing units adapted to be connected to said outlets, each of said breathing units comprising a face mask and a slave regulator in the form of a reducing valve adapted to reduce the intermediate oxygen pressure to a pressure required for breathing by the wearer of the mask, the apparatus being arranged so that the outlet pressure of the slave regulators at the face masks can be controlled by change of the master regulator outlet pressure.

2. A multiple outlet breathing apparatus according to Claim 1, wherein the master regulator is barometrically compensated to vary the intermediate pressure in accordance with surrounding atmospheric pressure.

3. A multiple outlet breathing apparatus according to Claim 2, wherein the master regulator is adapted to increase the intermediate pressure in response to decrease of atmospheric pressure.

4. A multiple outlet breathing apparatus according to Claim 3, in which the slave regulators of the individual breathing units are adapted to increase their outlet pressure (relative to atmosphere) in response to increase in the intermediate pressure in the manifold.

5. A multiple outlet breathing apparatus according to Claim 4, wherein the slave regulators each comprise a body having a valve member extending through a seating therein, the valve member being supported at one end by a small diaphragm mounted in the wall of the body of the inlet side of the valve and at the other end by a larger diaphragm mounted in the wall of the body on the outlet side, the head of the valve member being located on the inlet side of the seating.

6. A multiple outlet breathing apparatus according to Claim 4 wherein the slave regulators each comprise a body having an apertured seating member and a valve member extending therethrough so that the valve head is on the inlet side thereof, the valve member being secured to a diaphragm member mounted in the wall of the body on the outlet side of the valve and the seating

member being secured to a diaphragm mounted internally of the body, the diaphragms being so proportioned that an increase of inlet pressure increases the effective aperture of the valve.

7. A multiple outlet breathing apparatus according to Claim 6, wherein the exit of the passage through the seating member of the slave regulator discharges into a venturi and the wall of the body is apertured between the internal diaphragm and the venturi to draw external air into the oxygen fed to the mask.

8. A multiple outlet breathing apparatus according to Claim 2, in which the master regulator is adapted to decrease the intermediate pressure in response to decrease of atmospheric pressure.

9. A multiple outlet breathing apparatus according to Claim 8 in which the slave regulators of the individual breathing units are adapted to increase their outlet pressure (relative to atmosphere) in response to decrease in the intermediate pressure in the manifold.

10. A multiple outlet breathing apparatus according to Claim 9 wherein the slave regulators each comprise a body having a seating facing the inlet thereof, a valve member extending through the seating, the valve member being secured to a spring-opposed diaphragm mounted in the wall of the body on the outlet side of the valve.

11. A multiple outlet breathing apparatus according to any preceding claim wherein a barometrically-operated release valve is incorporated to admit oxygen automatically to the manifold when the ambient atmospheric pressure falls below a predetermined minimum value.

12. A multiple outlet breathing apparatus constructed and adapted to operate substantially as herein described with reference to the several Figures of the accompanying drawings.

STEVENS, LANGNER, PARRY
& ROLLINSON,

Chartered Patent Agents

and

Agents for the Applicants.

PROVISIONAL SPECIFICATION.

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“demand” type system, which is designed to supply oxygen at substantially constant pressure to the user.

It is an object of the present invention to provide a system in which several outlets are fed from one main regulator, as is required for use in multi-seat aircraft.

The regulator of an aircraft breathing

system contains a barometric element which is adapted to increase or decrease the pressure on the outlet side of the regulator in response to the surrounding atmospheric pressure so as to adjust the operation of the system relative to the surrounding atmosphere.

The main problem arising in using a single barometrically-compensated regulator for a multi-outlet system is that if the outlet pressure from the regulator is at the low pressure required for the mask supply, then very large pipes would be required for the leads from the regulator to the masks.

According to the present invention a multiple-outlet breathing system comprises a barometrically-compensated master regulator, having an inlet connected to a high-pressure supply and an outlet connected to a multiple-outlet distribution manifold, said master regulator being adapted to supply oxygen to the manifold at a varying pressure of the order of 100 p.s.i., said distribution manifold having outlets adapted to be connected to a mask through a slave regulator in the form of a reducing valve adapted to supply oxygen to the mask at the required pressure.

The supply of oxygen to the manifold at a relatively high pressure permits the manifold itself to be of relatively small diameter and, more important, permits the flexible pipes leading from the manifold to the slave regulator and the mask also to be of relatively small size. The actual pressure employed in the manifold may be varied through wide limits, it being really essential only that the pressure in the manifold should be barometrically-compensated and such that it provides adequate oxygen flow through relatively small diameter flexible hoses, whilst being at a pressure sufficiently low as to avoid damage to the flexible hoses connecting the manifold to the mask.

One oxygen breathing installation made in accordance with the present invention comprises a main oxygen supply, comprising oxygen cylinders adapted to supply oxygen at a pressure of, for example, 500—3000 p.s.i. or liquid oxygen evaporating equipment adapted to supply oxygen at a lower pressure to a master regulator which is barometrically compensated and of known construction and adapted to supply oxygen at a pressure of 60—120 p.s.i. to a manifold connected to the outlet of the master regulator. The manifold may be constructed of a relatively slender rigid metal tube, provided with a plurality of outlets, which are self-sealing and are adapted to receive an end connector member of a flexible hose, supplying a slave regulator and a mask.

The pressure in the hose will be the same, substantially, as the manifold pressure and the outlet pressure of the slave regulator has to be controlled between $-2''$ and $+20''$

water gauge, relative to the surrounding atmosphere to ensure that the mask pressure is physiologically correct.

The regulator system thus consists of the master regulator which controls the manifold pressure to 60—120 p.s.i. according to the altitude of the aircraft, whilst the slave regulators reduce the manifold pressure to the correct mask pressure for the altitude.

The slave regulator valve must be both compact and light for use in the present apparatus. One convenient form of slave regulator valve is a simple form of reducing valve which responds to inlet pressure in such a way that the pressure delivered to the mask increases as the pressure in the distribution manifold falls, so that with this type of slave regulator, the barometric element of the master regulator is set to reduce the manifold pressure with increase of altitude.

The reducing valve itself is shown in Figure 1 and consists of a valve member 1 attached to a diaphragm 2 mounted in the wall of the valve on the low pressure side of the valve. The diaphragm 2 is backed by a spring 3 held in a vented casing 4 on the outside of the valve, so that the spring 3 balances the differential pressure exerted on the diaphragm 2. The valve member 1 is provided with a spindle 5 and a conical head 5A. The conical head 5A is located in the high-pressure inlet side of the valve and the spindle 5 is supported in a guide 6 and connected to the diaphragm 2. Increase in oxygen pressure in the inlet passage 7 of the valve forces the valve head 5A towards the shoulder 8 and this reduces the effective aperture through which oxygen passes from the inlet passage 7 to the outlet passage 9. By correctly proportioning the parts of the valve, it can be arranged so that the pressure in the outlet 9 decreases as the pressure in the inlet 7 increases.

A modified construction of slave regulator is shown in section in Figure 2. This valve has been devised in order to give increased oxygen economy and is constructed so as to give increased mask pressure with increased inlet pressure. In consequence, the master regulator is arranged to give increase of manifold pressure with increase of altitude.

The modified regulator comprises a body 11, having inlet and outlet passages 12 and 14. A valve member 15 is secured to a diaphragm 16, backed by a spring 17 held in a case 18. As before, the valve member is provided with a spindle 19 and a conical head 20. In this case, although increased pressure in the inlet passage 12 causes the valve member to move towards its seating member 21, the seating member 21 in this instance is itself movable and is supported on the resilient bellows member 22, which moves further on increase of pressure in the inlet passage, with the result that the effective aperture between the valve head 20 and the

seating member 21 increases and in consequence the pressure in the passage 14 increases.

5 A further feature of this valve is that the body 11 of the valve is provided with a venturi 24 and is provided with air inlet ports 25, so that as oxygen issues from the seating member 21 into the venturi 24, it induces air through the ports 25 into the inlet passage 14, thus leading to a considerable economy in stored oxygen. As the bellows 22 expand, the tapered outer surface of the member 21 reduces the size of the effective aperture through which air can enter, eventually completely sealing it off, so that the slave regulator also automatically controls the composition of the breathing mixture delivered to the mask.

20 Emergency and test pressures can be obtained by increasing the pressure of the slave regulator spring by means of a cam or push button.

25 Failure to operate will be due to lack of pressure in the distribution manifold and a simple pressure gauge on the master regulator should give sufficient warning of faulty operation. Any failure in the slave regulator can be overcome by manual pressure on

its control spring as described above. Alternatively, a manual by-pass valve can be fitted, which would make the system equivalent to a conventional controlled flow type of apparatus. 30

The use of this system in civil aircraft has a number of advantages :— 35

1. The number of complex regulators can be greatly reduced.
2. The system will give complete safety up to the limit of pressure breathing conditions. 40
3. The master regulator incorporates a barometric control and can be arranged to operate automatically should the cabin altitude exceed, say, 10,000 ft.

An oxygen set suitable for baling out of an aircraft can be formed by connecting the slave regulator to a small storage cylinder fitted with a reducing valve. The reducing valve on the cylinder replaces the master regulator of the aircraft installation. 50

STEVENS, LANGNER, PARRY
& ROLLINSON,
Chartered Patent Agents,
Agents for the Applicants.

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Fig. 1.

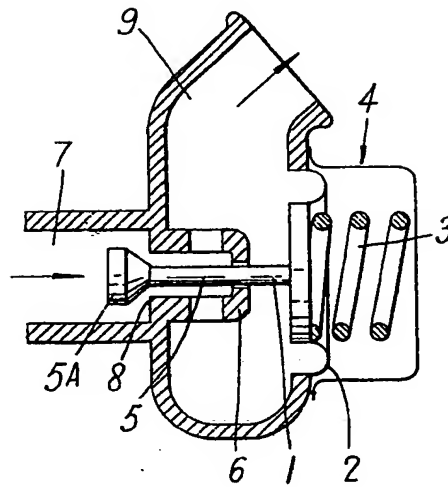
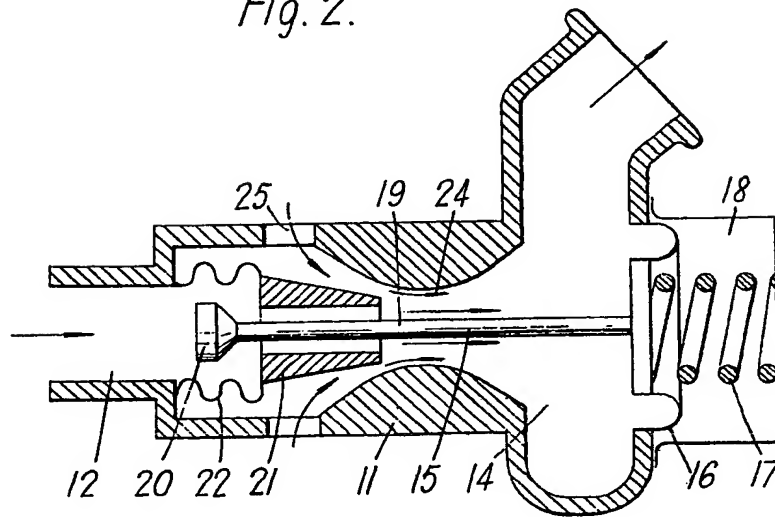


Fig. 2.



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